The Concept of Airspace Complexity and Its Use in Air Traffic Management

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The growth in air traffic and the new concepts in air traffic management (e.g., free flight) have increased the need to develop models and measures to describe traffic in the national airspace in order to predict air traffic controller workload and to make flow management decisions like resectorization. The complexity of the airspace depends on both *structural* measures and *flow* measures. The structural measures are fixed for a Sector/Center and depend on the spatial and physical features of the Sector. They are a function of attributes like terrain, number of airways, airway crossings, and navigation aids. The flow measures vary as a function of time and depend on such factors as the number of aircraft, mix of aircraft, weather, separation between aircraft, closing rates, aircraft speeds, and flow restrictions.

The Radio Technical Commission for Aeronautics task force report has emphasized the need to understand how airspace complexity affects controller workload. Controller workload has been measured in two ways: one based on the physiological state of the controller and another based on the physical interaction of the controller with the displays and other communication devices.

An effort was undertaken to develop and validate a measure of airspace complexity called dynamic density, which can be computed, in real time, from air traffic data inputs. The dynamic density function was developed based on interviews and survey techniques using qualified air traffic controllers. An activity catalog tool was developed to measure the controller activity. The dynamic density function has been linked with the Center/TRACON (Terminal Radar Approach Control) Automation System (CTAS) software. Preliminary results from tests of the density function at the Denver Air Route Traffic Control Center (ARTCC) airspace show a good correlation between dynamic density and controller activity.

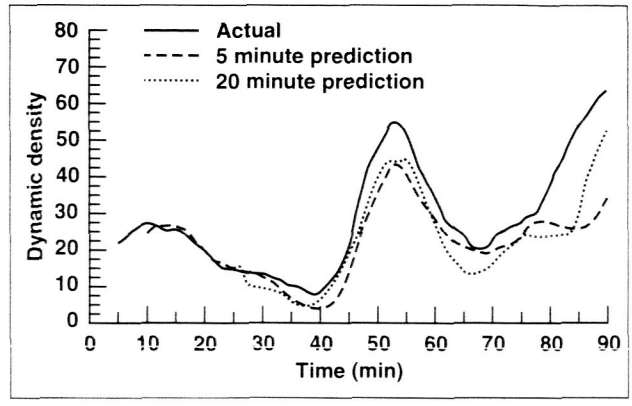

Fig. 1. Predictions of dynamic density at Denver Air Route Traffic Control Center.

Currently, Ames is evaluating application of the dynamic density measure, developed using data from the Denver Center, to traffic situations in other Centers; in addition, alternative measures for dynamic density are being developed.

In order for dynamic density to be useful as a planning tool, it is necessary to be able to predict its behavior. The figure shows the prediction of dynamic density 5 and 20 minutes in the future for Sector 16 at Denver Center. The prediction faithfully depicts the "ups" and "downs" of the actual dynamic density. The predictions deviate from actual values when the number of aircraft and their "intent" information are not known to CTAS software. This limitation can be overcome in the future when intercenter data become available to the system.

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